Figure 3 - RF Test Bed for DTV interference measurements

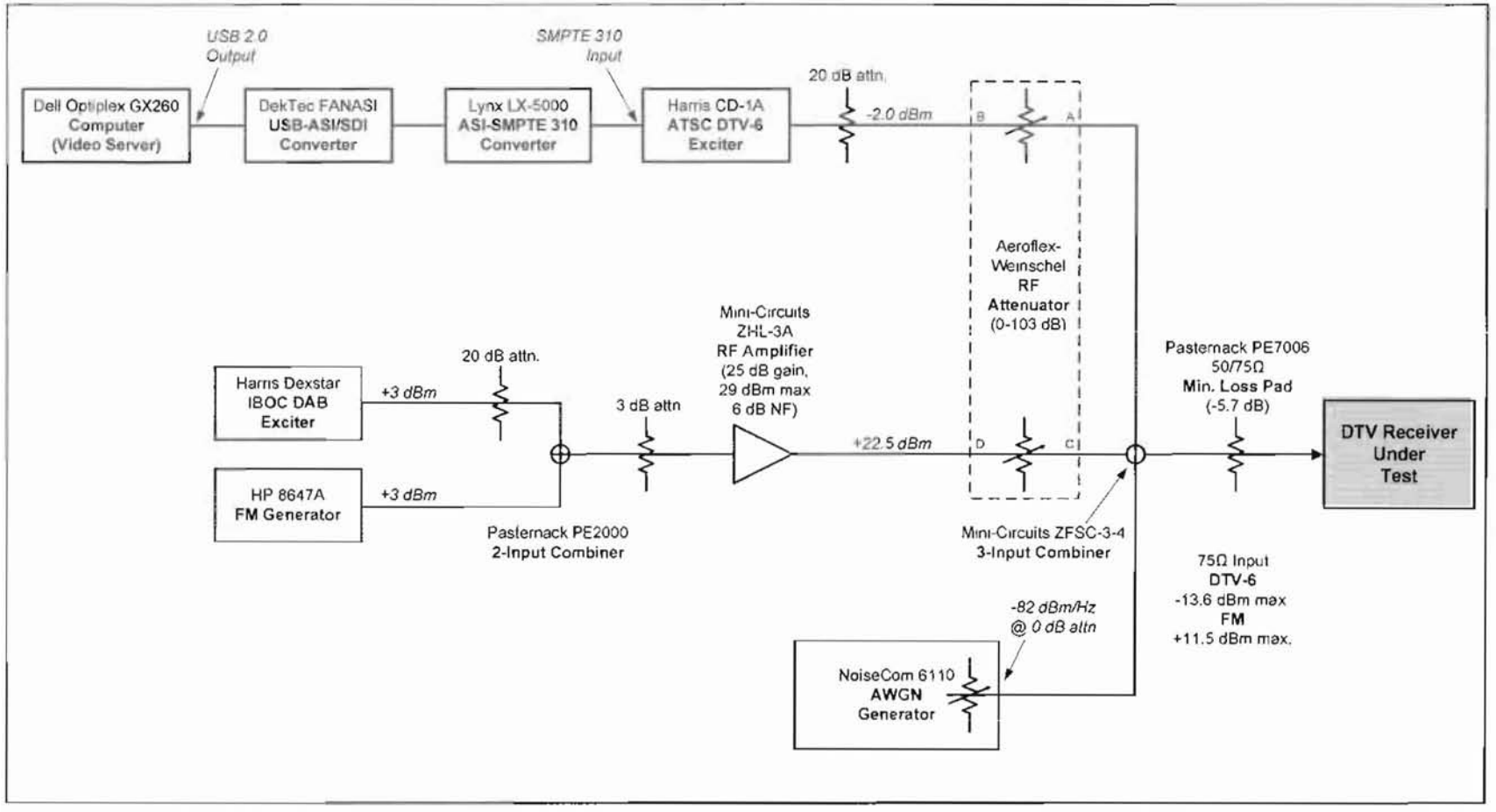


Table 2 - Measurements of FM to DTV-6 signal ratios for TOV at -68 dBm DTV

	MHz:	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9
Make	**Model**																				
DigitalStream	D2A1D20	32.2	42.2	43.2	43.2	43.2	43.2	44.2	45.2	45.2	45.2	45.2	46.2	47.2	47.2	48.2	49.2	49.2	49.2	49.2	50.2
Durabrand	DTV1307	26.2	41.2	43.2	44.2	45.2	45.2	46.2	46.2	47.2	47.2	48.2	48.2	48.2	49.2	49.2	49.2	49.2	49.2	49.2	50.2
Hitachi	P50H401	15.1	32.1	37.1	41.1	43.1	44.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1	47.1	47.1	47.1	48.1	48.1	49.1	49.1
Insignia	NS-F24TV	22.1	45.1	46.1	47.1	48.1	48.1	48.1	49.1	49.1	49.1	50.1	50.1	51.1	51.1	51.1	51.1	52.1	52.1	53.1	53.1
LG	37LC7D	34.2	39.2	44.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	51.2	51.2	51.2	52.2	53.2
LG (Zenith)	LSX300-4DM	33.3	38.3	39.3	39.3	39.3	40.3	41.3	41.3	41.3	41.3	41.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	45.3	45.3
Philips	37PFL5332D	5.3	28.3	30.3	43.3	43.3	45.3	45.3	45.3	47.3	47.3	48.3	49.3	50.3	51.3	52.3	53.3	52.3	53.3	54.3	54.3
OnAir Solutions	HDTV GT	17.1	27.1	37.1	38.1	38.1	39.1	39.1	40.1	40.1	41.1	41.1	41.1	42.1	43.1	43.1	44.1	45.1	45.1	46.1	47.1
Pinnacle	PCTV HD	7.3	14.3	26.3	41.3	44.3	44.3	45.3	45.3	45.3	47.3	47.3	47.3	46.3	48.3	43.3	43.3	43.3	48.3	44.3	48.3
RCA	20F514TD	29.2	41.2	44.2	45.2	45.2	45.2	46.2	46.2	47.2	47.2	48.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	50.2	51.2
Samsung	DTB-H260F	16.2	30.2	40.2	42.2	43.2	43.2	43.2	44.2	44.2	44.2	45.2	45.2	45.2	45.2	46.2	46.2	47.2	47.2	47.2	47.2
Samsung	LN-T4061F	26.3	29.3	29.3	41.3	41.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	45.3	45.3	45.3	46.3	47.3	47.3	48.3	49.3
Sharp	LC-32D43U	19.1	32.1	46.1	46.1	46.1	45.1	44.1	43.1	42.1	42.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	45.1
Sanyo	DP32647	17.3	29.3	36.3	38.3	40.3	44.3	44.3	45.3	45.3	46.3	47.3	48.3	49.3	49.3	50.3	51.3	52.3	53.3	53.3	54.3
Sony	KDL-46XBR2	21.1	41.1	41.1	41.1	41.1	41.1	41.1	41.1	42.1	42.1	43.1	43.1	43.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1
Toshiba	19HLV87	22.3	23.3	36.3	43.3	44.3	44.3	45.3	45.3	45.3	45.3	46.3	46.3	46.3	46.3	47.3	47.3	47.3	47.3	48.3	48.3
Westinghouse	SK-42H240S	18.3	34.3	41.3	43.3	43.3	44.3	45.3	45.3	46.3	46.3	47.3	47.3	48.3	49.3	49.3	49.3	50.3	51.3	51.3	52.3
Median		21.1	32.1	40.2	43.2	43.3	44.3	44.3	45.3	45.3	45.3	46.3	46.3	46.3	47.2	47.3	47.3	48.1	48.3	49.1	49.3

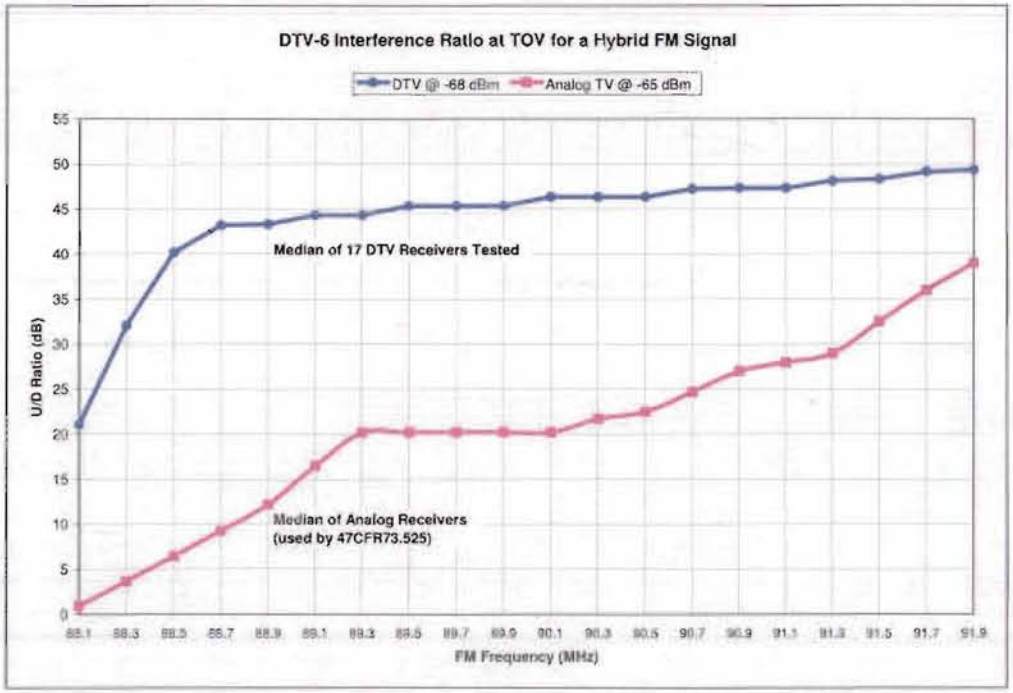


Table 3 - Measurements of FM to DTV-6 signal ratios for TOV at -53 dBm DTV

	MHz:	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9
Make	**Model**																				
DigitalStream	D2A1D20	31.2	42.2	42.2	42.2	43.2	43.2	42.2	44.2	44.2	45.2	45.2	45.2	46.2	47.2	47.2	48.2	48.2	49.2	50.2	50.2
Durabrand	DTV1307	25.2	42.2	43.2	44.2	45.2	46.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	50.2	50.2
Hitachi	P50H401	15.1	32.1	37.1	42.1	43.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1	46.1	46.1	47.1	47.1	48.1	48.1	49.1	49.1
Insignia	NS-F24TV	23.1	45.1	46.1	47.1	47.1	48.1	48.1	48.1	49.1	50.1	50.1	50.1	50.1	50.1	51.1	51.1	52.1	52.1	52.1	52.1
LG	37LC7D	34.2	40.2	44.2	46.2	46.2	46.2	46.2	47.2	48.2	48.2	49.2	49.2	50.2	50.2	50.2	51.2	51.2	52.2	52.2	52.2
LG (Zenith)	LSX300-4DM	32.3	40.3	41.3	41.3	42.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	44.3	45.3	56.1	45.3	46.3	46.3	46.3	46.3
Philips	37PFL5332D	9.3	32.3	33.3	45.3	45.3	46.3	46.3	47.3	48.3	48.3	50.3	50.3	51.3	51.3	52.3	53.3	54.3	54.3	54.3	54.3
OnAir Solutions	HDTV GT	17.1	27.1	38.1	38.1	38.1	39.1	39.1	40.1	40.1	41.1	41.1	42.1	42.1	42.1	43.1	44.1	44.1	45.1	46.1	46.1
Pinnacle	PCTV HD	6.3	14.3	26.3	42.3	43.3	43.3	45.3	44.3	46.3	45.3	46.3	46.3	46.3	45.3	47.3	40.3	45.3	44.3	45.3	45.3
RCA	20F514TD	28.2	42.2	44.2	44.2	44.2	45.2	45.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	50.2	50.2	50.2	50.2
Samsung	DTB-H260F	15.2	30.2	41.2	43.2	44.2	44.2	44.2	44.2	45.2	45.2	46.2	46.2	46.2	46.2	47.2	47.2	47.2	48.2	48.2	48.2
Samsung	LN-T4061F	26.3	29.3	30.3	41.3	42.3	42.3	42.3	42.3	42.3	42.3	43.3	43.3	44.3	44.3	45.3	46.3	84.3	47.3	47.3	48.3
Sharp	LC-32D43U	18.1	32.1	46.1	46.1	46.1	45.1	45.1	44.1	43.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	46.1	46.1
Sanyo	DP32647	17.3	28.3	38.3	38.3	40.3	43.3	44.3	44.3	44.3	45.3	46.3	47.3	48.3	49.3	50.3	50.3	52.3	52.3	53.3	54.3
Sony	KDL-46XBR2	20.1	40.1	41.1	41.1	41.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	46.1	46.1
Toshiba	19HLV87	21.3	21.3	36.3	42.3	44.3	44.3	44.3	45.3	45.3	45.3	46.3	46.3	46.3	46.3	46.3	47.3	47.3	48.3	48.3	48.3
Westinghouse	SK-42H240S	19.3	34.3	42.3	42.3	43.3	44.3	44.3	45.3	46.3	46.3	47.3	47.3	48.3	49.3	50.3	50.3	50.3	51.3	51.3	52.3
Median		20.1	32.3	41.2	42.3	43.3	44.2	44.3	44.3	45.2	45.3	46.3	46.3	46.3	46.3	47.3	47.3	48.2	48.3	49.1	49.1

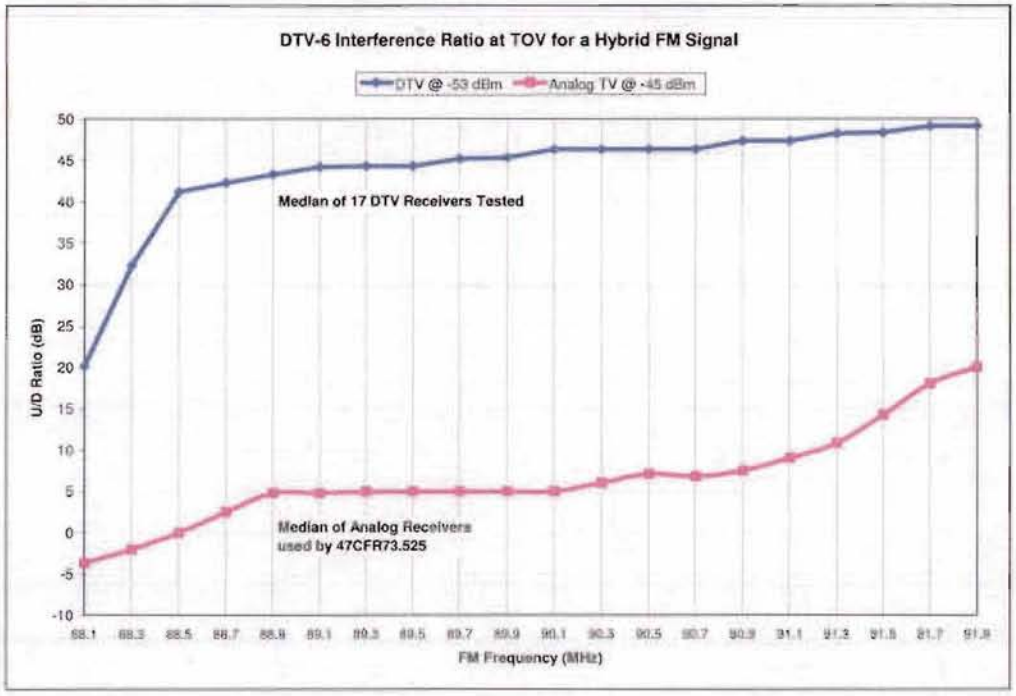
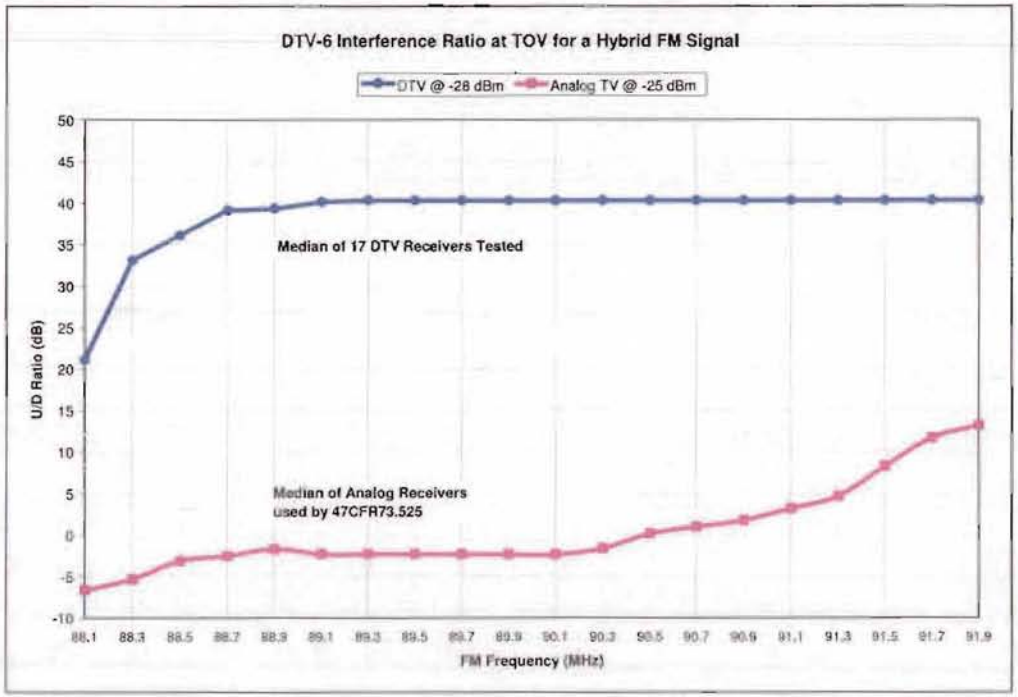


Table 4 - Measurements of FM to DTV-6 signal ratios for TOV at -28 dBm DTV

	MHz:	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9
Make	**Model**																				
DigitalStream	D2A1D20	31.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
Durabrand	DTV1307	24.2	38.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Hitachi	P50H401	16.1	33.1	36.1	39.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Insignia	NS-F24TV	23.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
LG	37LC7D	30.2	34.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
LG (Zenith)	LSX300-4DM	35.3	37.3	38.3	38.3	38.3	38.3	38.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Philips	37PFL5332D	9.3	30.3	33.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
OnAir Solutions	HDTV GT	17.1	28.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Pinnacle	PCTV HD	7.3	14.3	27.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	39.3	39.3	39.3	40.3
RCA	20F514TD	31.2	37.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Samsung	DTB-H260F	17.2	33.2	38.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Samsung	LN-T4061F	25.3	31.3	33.3	38.3	38.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sharp	LC-32D43U	18.1	32.1	39.1	39.1	39.1	40.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sanyo	DP32647	17.3	28.3	34.3	35.3	35.3	36.3	36.3	36.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sony	KDL-46XBR2	21.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1
Toshiba	19HLV87	21.3	21.3	34.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Westinghouse	SK-42H240S	17.3	36.3	38.3	38.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Median		21.1	33.1	36.1	39.1	39.3	40.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3



APPENDIX B:

NPR Labs Report, Comparison of FM Broadcast Signal Interference Areas with Current Digital Television Receivers on Channel 6 to Analog TV Receivers Assumed in 47 CFR 73.525

Comparison of FM Broadcast Signal Interference Areas with Current Digital Television Receivers on Channel 6 to Analog TV Receivers Assumed in 47 CFR 73.525

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Washington, DC 20001

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Executive Summary

This report contrasts the potential interference to reception of digital TV channel 6 from NCE-FM signals, as measured with current digital television receivers, to the interference ratios employed in the FCC's rules protecting analog TV channel 6 stations (47CFR73.525). These rules were adopted in 1985, using interference measurements of analog (NTSC) television receivers available in 1979. In anticipation of the conversion to digital television broadcasting and termination of analog TV transmission in early 2009, NPR Labs conducted a full-scale study of consumer digital televisions for FM interference susceptibility, detailed in *Interference Rejection Thresholds of Consumer Digital Television Receivers on Channel 6 with FM Broadcast Signals, December 17, 2007*. The results of that study are used herein to illustrate the physical reduction in interference that may be caused to digital TV reception on channel 6, relative to the current analog protection rules.

The measurements for the digital TV study were carried out in the test facility at NPR Labs, in the Washington, DC headquarters of National Public Radio. The results are based on 17 digital television receivers selected to represent a wide range of currently-available digital television receivers. The receivers included two low-cost set-top boxes certified by the NTIA for coupon rebate, computer "USB stick" tuners, table-top sets and flat screen TVs from 19 to 50 diagonal inches. Picture impairment was determined at TOV (threshold of visibility), representing the most critical ratios of interference. The digital sound was also monitored for impairment for each receiver.

Figure 1- Improvement in mean DTV-6 Interference Ratios Relative to FCC Analog TV-6 Ratios

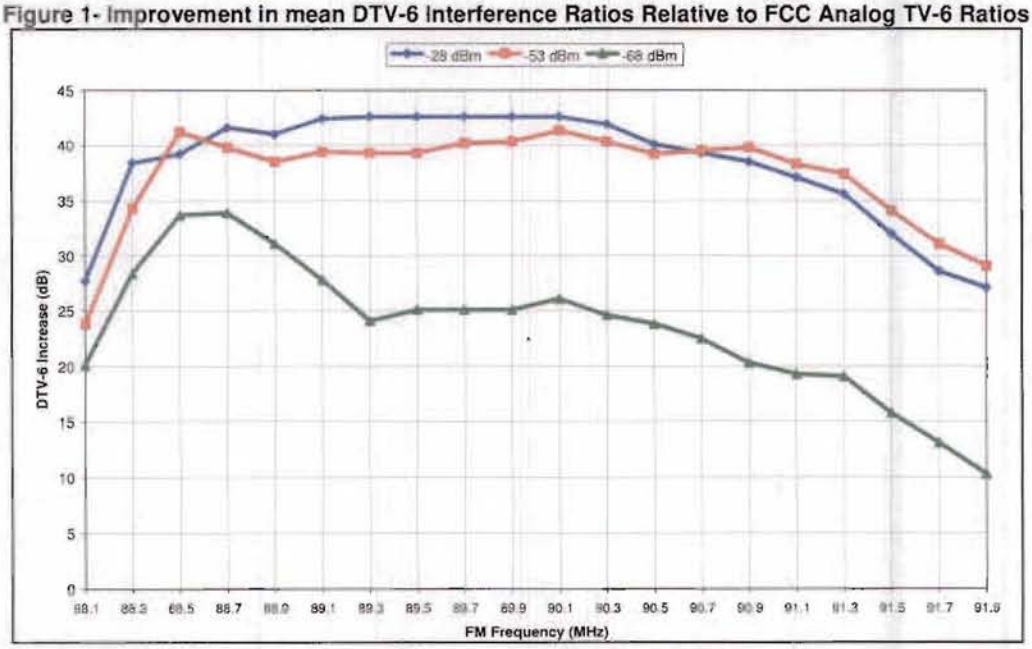


Figure 1 compares the differences between the measured interference ratios of the DTV receivers to the FCC's original ratios for analog TV receivers, on which the existing channel 6 protection rules are based, for non-commercial FM channels 201 to 220

(88.1 MHz to 91.9 MHz) on three desired signal powers representing strong, medium and weak signal strengths. The graph shows that the DTV-6 interference thresholds are from 10 to 43 dB better than the original analog receiver thresholds. It should be mentioned that the laboratory test bed was limited to an interfering signal power of +11.5 dBm (equivalent to the field strength produced by a 100 kW FM at one mile). Many of the receivers did not experience interference at some FM frequencies with desired signal powers at -53 dBm and -28 dBm (note the flattening in curves above 88.9 MHz). In these cases, the interference ratios were based on the maximum supplied by the test bed, even if the receiver exhibited no interference.

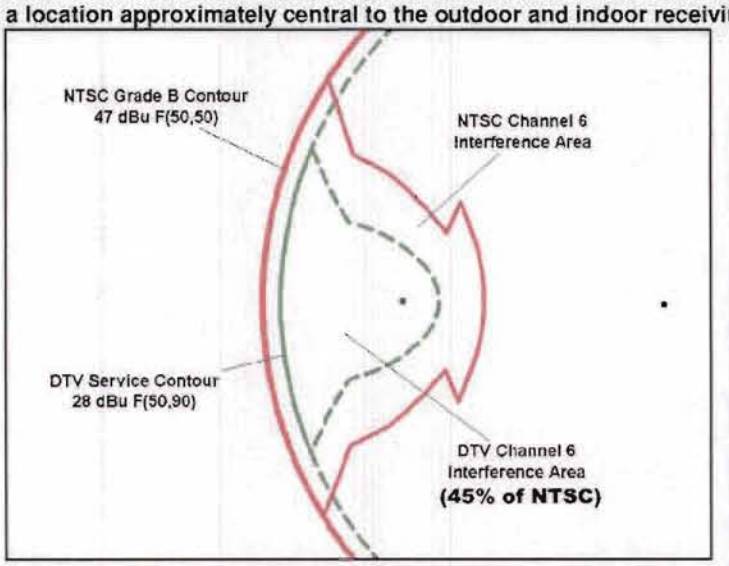
While Figure 1 provides evidence of the substantial improvement in interference ratios with current DTV receivers, the effect of these ratios in reducing interference areas may not be apparent. Therefore, the following section applies the ratios to calculations for several DTV and NTSC (analog) receiver interference examples and discusses the differences. Frequencies for the lowest, middle and highest NCE-FM channels were used. FM transmitter locations within the F(50,90) 28 dBu DTV Service Contour and the F(50,90) 59 dBu contour[1] were selected to represent the fringe or outdoor and indoor reception, respectively. As detailed below, the examples demonstrate that the DTV interference areas would range from 45 percent to as little as 2 percent of the comparable analog TV interference areas. Reduction in the interference populations would be equivalent, if the populations were distributed uniformly within the region.

[1] An omni-directional TV receive antenna pattern was used for an indoor receive antenna specified in the OET Bulletin No. 69 (February 2004), was locations inside the TV 59 dBμ F(50,90) contour to consider the use of
employed for locations outside the TV 59 dBμ F(50,90)5 contour to consider the use of an outdoor receive antenna

Calculation of Interference Areas

For the analog TV channel 6 station, the procedures specified in Section 73.525 of the Commission's rules were followed. A hypothetical facility with 100 kilowatts peak visual power was assumed at a height of 610 meters, representing the maximum facilities for an analog TV channel 6 operation in Zone II or Zone III. The site of the hypothetical TV channel 6 station is shown as a black dot near the right edge in Figure 1 and successive figures. This operation produces an F(50,50) 47 dBμ Grade B contour distance of 128.8 kilometers,[2] shown with a red contour arc.

Figure 2 – Outdoor TV channel 6 interference map for FM channel 201 for NTSC analog (red) and DTV (green) at a location approximately central to the outdoor and indoor receiving distances.



The hypothetical NCE-FM station is shown as the black dot near the center, within the interference area in each figure. A full Class B1 facility (25 kilowatts at 100 meters AAT) was assumed for the FM station on channel 201 (88.1 MHz). While the power and height of FM facilities varies widely, this facility was chosen as typical of new NCE-FM stations, which are frequently limited in power and height by protection to other FM stations. The analog TV channel 6 interference contour is shown as the irregularly-shaped contour, in red, bounded on the left by the TV Grade B contour.[3] The interference contours shown herein are scaled identically to the Grade B contour, with each assuming uniform (flat) terrain elevation.

[2] The maximum channel 6 TV height in Zone I for 100 kW is 305 m AAT, resulting in a smaller Grade B distance of 104.0 kilometers.

[3] All service contours and interference contours were calculated for NPR Labs by the consulting engineering firm Cavell Mertz & Associates, Inc., using the same computer program employed for NCE-FM applications involving routine TV channel 6 interference calculations.

The DTV 6 facility was assumed to be 45 kilowatts at 305 meters AAT, producing a F(50,90) service contour of 28 dBμ, shown in Figure 2 by a green arc, which is concentric to the analog Grade B contour.[4] This facility was intended to represent the maximum DTV operation on channel 6, rather than matching the analog channel 6 coverage. The NCE-FM interference contour was computed in the same manner as the analog TV channel 6 station, that is, per Section 73.525, with the following changes:

- The interference ratio for each NCE-FM channel was determined from the median DTV receiver interference threshold measurements at the appropriate FM channel, as described in *Interference Rejection Thresholds of Consumer Digital Television Receivers on Channel 6 with FM Broadcast Signals*, prepared by NPR Labs. As interference ratios measured at equivalent received signal powers of -68 dBm and -53 dBm were very similar, these ratios were averaged together and used for the interference predictions. (The report's interference measurements at a DTV signal power -28 dBm were not required for these examples.) The undesired to desired (U/D) signal level ratios provided by NPR Labs used to predict the location of FM interference are as follows:
    - Channel 201 Analog: 1.0 dB, DTV: 20.1 dB
    - Channel 209 Analog: 20.2 dB, DTV: 45.2 dB
    - Channel 219 Analog: 39.0 dB, DTV: 49.1 dB
- Using the DTV link budget described in FCC OET Bulletin No. 69, *Longley-Rice Methodology for Evaluating TV Coverage and Interference*, (February 6, 2004), an F(50,90) field strength of 59 dBμ was determined to represent the limit of indoor service, assuming average residential building penetration loss and a low-gain indoor antenna. Although real consumer antennas may provide some directivity and interference discrimination, the indoor receive antenna was assumed to be omnidirectional with a 0 dBd gain. This made the indoor calculations for DTV interference slightly worse than the "rabbit-ear" antenna specified by the FCC rules and used herein for analog TV channel 6 interference. To conform to the analog interference methodology contained in Section 73.525, building penetration loss was not included in the calculation of interference within the 59 dBμ DTV contour.
- Beyond the 59 dBμ field strength of the DTV channel 6 station, a directional TV receive antenna pattern as specified in FCC OET Bulletin No. 69 was assumed for the outdoor DTV receiving antenna. This pattern is less directive than the pattern specified in Section 73.525, which is a conservative assumption that would result in more calculated DTV interference.

[4] Although the FCC's link budgets for deriving analog Grade B and DTV Service Contour are comparable, it should be noted that the DTV link budget indicates the digital reception "cliff". Consumer reception may require a signal margin for reliable reception near the service limit, thereby reducing the distance to usable service contour and the corresponding NCE-FM interference area.

Figure 3 shows the calculated interference areas for indoor analog and digital TV channel 6 reception, using methods prescribed by Section 73.525 rules and the above modifications for DTV, respectively.

Figure 3 – Indoor TV channel 6 interference calculation map for FM channel 201 for NTSC analog (red) and DTV (green).

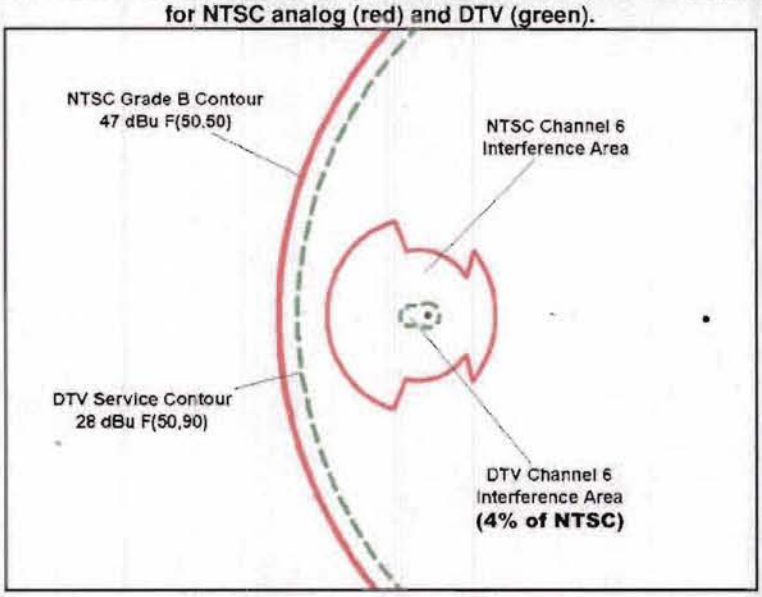


Figure 4 and Figure 5 show the respective interference areas for analog and digital TV channel 6 with FM channel 209. This channel is near the center frequency of the Reserved Band for noncommercial FM. Because of the large increase in allowable U/D ratios for both analog TV and DTV at FM channel 200, the interference area is substantially smaller than channel 201 in the first two examples. With a 25 dB U/D ratio advantage over analog TV, the DTV interference area is noticeably smaller for the indoor interference study. The indoor DTV interference includes a small lens-shaped piece at the 28 dBu DTV Service Contour, which was included in the area total. The differences in shape between the analog and digital interference contours are due in large part to the antenna directivities assumed for each service, as defined earlier herein.

Figure 4 - Outdoor TV channel 6 interference map for FM channel 209 for NTSC analog (red) and DTV (green).

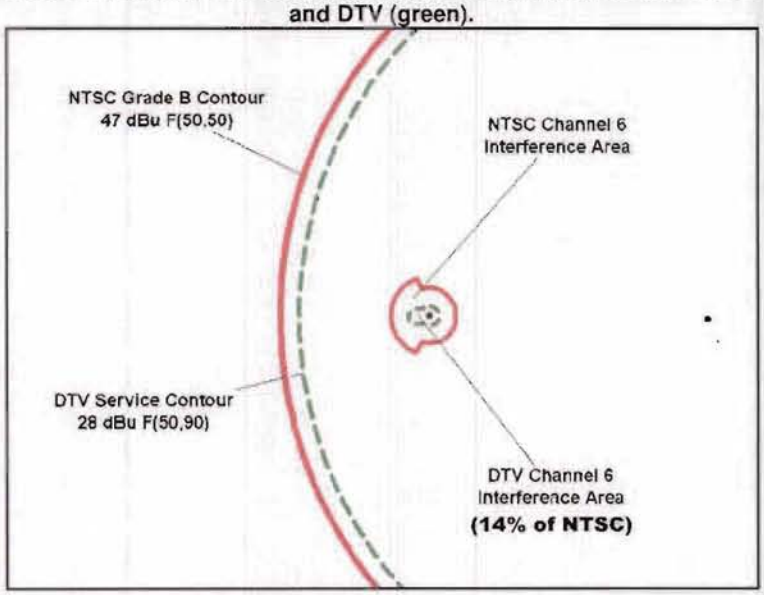


Figure 5 - Indoor TV channel 6 Interference map for FM channel 209 for NTSC analog (red) and DTV (green).

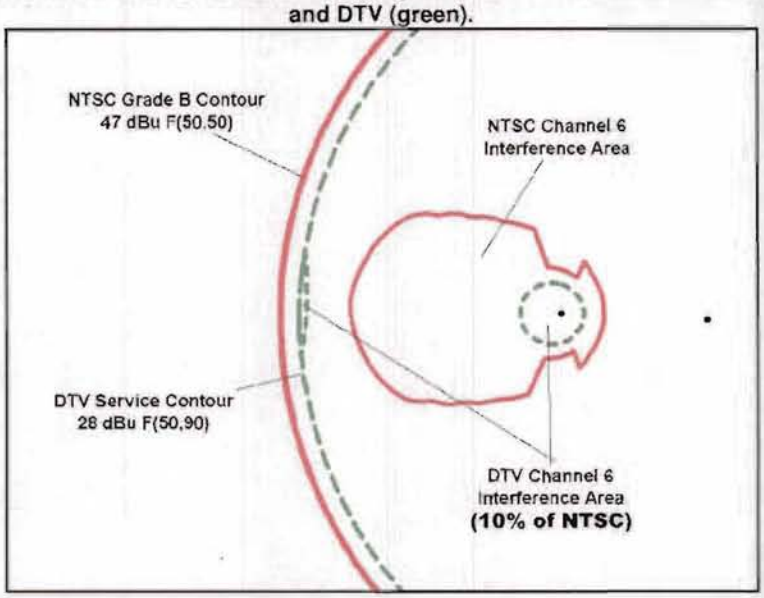


Figure 6 and Figure 7 provide a comparison between analog and digital TV channel 6 interference on channel 219, which is the highest channel in the Reserved Band. With the largest frequency separation from channel 6, these ratios are the most favorable to channel 6 for both analog and digital interference. Similar to the previous examples, the NCE-FM interference contours for DTV result in far smaller interference areas than for analog TV.

Figure 6 - Outdoor TV channel 6 interference map for FM channel 219 for NTSC analog (red) and DTV (green).

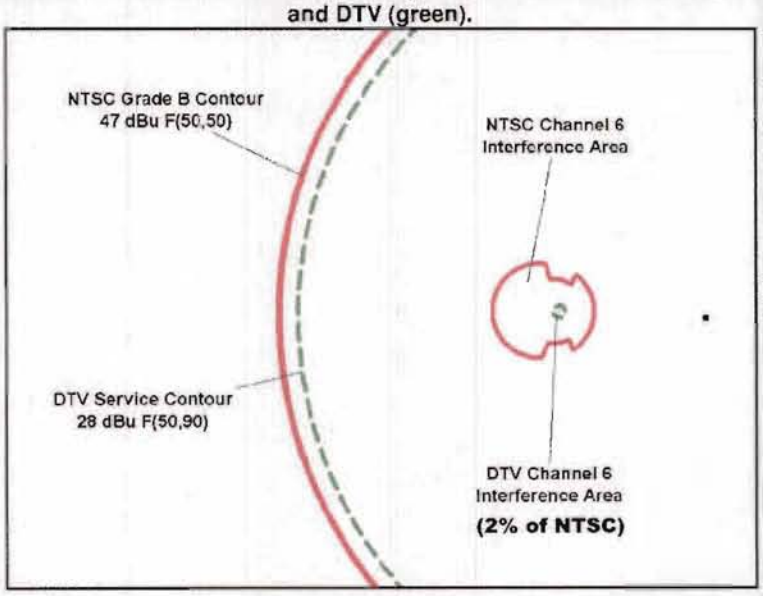
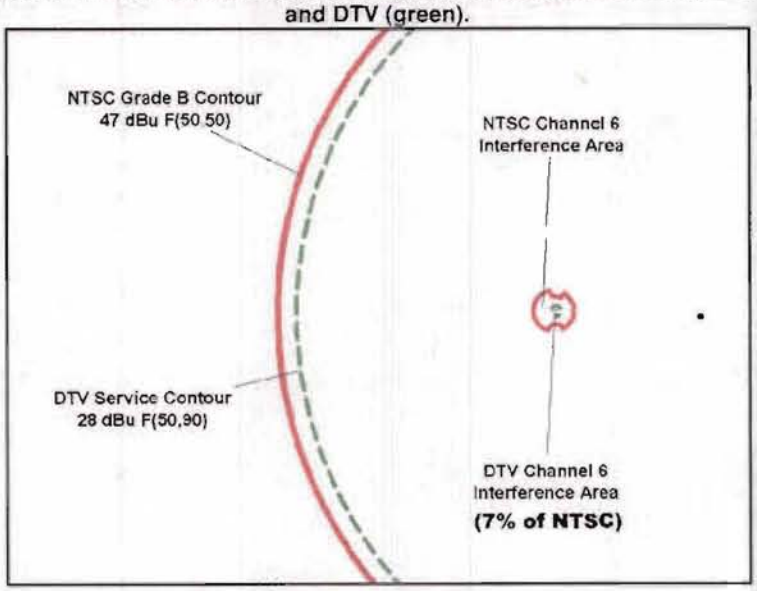


Figure 7 - Indoor TV channel 6 interference map for FM channel 209 for NTSC analog (red) and DTV (green).



The results of the calculated interference areas are summarized in Table 1. For each figure, the calculated area in square kilometers is shown for both NTSC and DTV interference. Figures 2, 3 and 4 depict interference where the hypothetical FM station is near the Grade B contour for NTSC or near the 28 dBu Service Contour for DTV. Figures 5, 6 and 7 depict interference for a NCE-FM station located near the Grade A contour for NTSC or a calculated 59 dBu field strength estimated for indoor DTV reception. The ratios of DTV interference area to NTSC analog are provided in the column to the right.

Table 1 - Calculation of interference areas

Figure Number	TV-6 System	Channel	FM Station Location	Area sq km	DTV Interference Area vs. NTSC Interference Area
2	NTSC	201	In Grade B (NTSC) or In Service Contour (DTV)	5601	45%
	DTV			2531	
3	NTSC	209		1908	4%
	DTV			69	
4	NTSC	219		295	14%
	DTV			40	
5	NTSC	201	In Grade A (NTSC) or In 59 dBμ (DTV)	3289	10%
	DTV			321	
6	NTSC	209		625	2%
	DTV			10	
7	NTSC	219		106	7%
	DTV			7	

APPENDIX C:

Hammett & Edison, Inc. Report, Noncommercial FM Stations and TV Channel 6 Protection

HAMMETT & EDISON, INC.
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BY E-MAIL MSTARLING@NPR.ORG

November 11, 2004

Michael I. Starling, Esq.
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National Public Radio
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Dear Mike:

As requested, we have completed study work regarding noncommercial FM (NCE-FM) stations and TV Channel 6 ("TV6") protection as we move into the digital television (DTV) transition. This project work is based on our e-mail quotation of January 28.

Background

Compliance with FCC Rules Section 74.525, "TV Channel 6 Protection," has always been challenging for NCE-FM stations located in the vicinity of NTSC TV6 broadcast stations. This rules section, added in the mid-1980s, is intended to curb the likelihood of, and to address specific remedies for, destructive interference being received by over-the-air TV6 (82-88 MHz) viewers from NCE-FM stations operating in the 88.1-91.9 MHz reserved band. Lacking a blanket waiver by the potentially affected TV6 station (a power that the rule clearly delegates), NCE-FM stations located within or near the Grade B contour of the TV6 station have had to reduce power, operate with vertical-only or elliptical polarization instead of circular polarization, employ directional transmitting antennas, collocate with the TV6 station, coordinate distribution and installation of interference filters, or employ combinations of these requirements in order to meet the requirements of the rule.

Your supposition was that the FCC might just delete the Rules Section 73.525 TV6 protection requirements, entirely, at the conclusion of the DTV transition period.* In that case, a significant number of NCE-FM stations might be able to improve their technical facilities, and

* In fact, the FCC's recent Report and Order to MB Docket 03-15 regarding DTV transition issues and procedures gives special consideration to accommodate low-band VHF NTSC stations (operating on Channels 2 through 6) that do not wish to return to their low-band VHF channel for post-transition DTV operation. Technical concerns include undesirable noise sources and propagation effects prevalent within that frequency range.

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hence overall facility coverage, by eliminating existing TV6 protections. Thus, we concluded that a useful study would be to determine how many stations would be affected, and what degree the expected improvement might be for the "average" affected station.

Study Overview

There are 58 licensed, domestic, full-service NTSC TV6 stations, so all affected NCE-FM stations would be near those facilities. Section 73.525(a)(1) specifies distances to TV6 stations, ranging from 154 to 265 kilometers, depending on NCE-FM channel, for which protection studies are required. Using the median distance of 196 kilometers, we determined a universe of 1,759 licensed, domestic, full-service NCE-FM stations that could be actively protecting a TV6 facility.

To narrow the field of station study candidates, we identified NCE-FM stations employing vertical-only polarization, those employing both antenna polarizations but with greater vertical polarization power (*i.e.,* elliptical polarization), NCE-FM stations that are collocated with TV6 stations, and NCE-FM stations having directional antenna patterns that appear to limit radiation toward a TV6 facility. The use of such a multi-part culling method reduced, to 407, the universe of affected NCE-FM stations to be considered. Of these, allocation studies were conducted on 25 of these facilities (8.1%), with the intention of determining weighted "improvement factors," related to return of circular polarization, overall power increase possibility, and/or relaxation or elimination of directional antenna patterns.† 2000 U.S. Census data was used to determine a nominal population percentage improvement to the present 60 dBu coverage area for each NCE-FM station identified as having upgrade potential.

Station Selection and Study Procedure

Studied NCE-FM facilities were selected in a pseudo-random fashion, weighted in accordance with the universe of stations found in each subcategory during database culling. As shown in the table of accompanying Figure 1, 13 stations employing vertical-only polarization, six stations using elliptical polarization, four stations collocated with NTSC TV6 stations, and two stations having directional transmitting antennas apparently protecting TV6 reception areas were selected for study. Specific stations selected for study were determined by dividing each subcategory, which listed stations alphabetically by community of license (without regard to state or geographic area), into equal parts proportional to the number of stations to be selected for study. For example, the universe of 212 vertical-only polarization stations was cut into 13 approximately equal parts, using a randomly-selected starting point within the list, and the first 13 stations found in each part were selected for study.

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† Some factors, such as the ability to relocate a NCE-FM facility to a more desirable site, are probably real but were considered too subjective for a study that is meant to provide a general indication of potential improvement.

In addition to the study type category, the table of Figure 1 includes specific studied station callsign, channel/class, location, transmitting antenna type (directional or nondirectional), effective radiated power (ERP), and FCC Facility ID number. The associated affected NTSC TV6 stations are included, by callsign and location, along with distance and bearing information between the NCE-FM and TV6 stations. Note that three studied NCE-FM stations (Seq. Nos. 5, 9, and 19) had two TV6 stations each within the 196-kilometer search area.

Without regard to the TV6 station presence, FCC allocation contour studies were conducted for each of the 25 studied NCE-FM stations to determine the potential for improved coverage areas. The table of accompanying Figure 2 provides a summary of the study results, based on co-channel and first-, second-, and third-adjacent channel contour relationships to other stations. An entry of "OK" indicates no particular limitation for a given channel relationship, where a callsign and direction entry indicate a limiting station. In cases where more than one station is involved in a limitation for a given channel relationship, the total number of stations are specified.

An additional column, added for informational purposes, lists whether the studied NCE-FM station 60 dBu contour enters the 47 dBu (Grade B) contour area of the TV6 station, and if so, the approximate percentage of FM contour contained within the TV6 contour. A "Y" with no percentage shown indicates that 100% of the FM contour is contained within the TV6 contour. By definition, the contour of a collocated NCE-FM station is entirely contained within the TV6 contour.

Finally, the right-most column of the table of Figure 2 specifies the determination of whether the studied NCE-FM station may likely increase its service area. The determination "No Increase" means that the close proximity of other station contours or existing contour overlap effectively prohibits any service area increase for that station. The entry "No Practical Increase" means that while some opportunity may exist in given direction(s) to increase service area, the need for a complex directional transmitting antenna pattern likely leads, in our opinion, to a diminishing returns condition, so no practical increase opportunity would be present. One NCE-FM station, WTLI (Seq. No. 1) is limited by a pending application, while another, WMFL (Seq. No. 4), would be maximized if its existing FCC construction permit were implemented. Neither of these stations was studied further. However, four stations were identified as likely power increase candidates, while a fifth station was identified as a candidate to significantly relax present restrictions toward its associated TV6 station.

Study Findings

For the five NCE-FM stations identified as being able to increase service area, improved transmitting facilities were designed and 2000 U.S. Census population increases were determined. Maps depicting existing and increased service areas are provided in accompanying Figures 3A-3E. A brief discussion of each studied facility is provided below:

1. FM Station KDRH, 91.3 MHz, Channel 217A, King City, California - This station utilizes a nondirectional transmitting antenna (vertical polarization only) operating at 300 watts ERP. TV6 Station KSBY is located 108.4 kilometers to the southeast. Our allocation study findings show that lacking the FCC Rules Section 73.525 restriction, KDRH could increase power to the 6 kW ERP Class A maximum using a circularly-polarized transmitting antenna. The increased 60 dBu contour would add Soledad to the coverage area, for a 56% population increase.

2. FM Station WVLS, 89.7 MHz, Channel 209B1, Monterey, Virginia - WVLS employs a directional transmitting antenna (vertical polarization only) operating at 360 watts ERP. TV6 Station WVVA is located 184.6 kilometers to the southwest. Our allocation study findings show that WVLS can increase power to 450 watts ERP and employ a nondirectional circularly-polarized transmitting antenna, yielding an 82% gain in population served. However, it is likely that WVLS could accomplish at least most of this increase under the current FCC Rules, since the Rules Section 73.525 impact appears minimal.

3. FM Station WMLU, 91.3 MHz, Channel 217A, Farmville, Virginia - WMLU, licensed to Longwood University, operates with a nondirectional transmitting antenna using elliptical polarization operating at 150 watts ERP vertical, 1 watt horizontal. Our allocation study findings show that lacking the FCC Rules Section 73.525 restriction, WMLU could increase power to the 6 kW ERP Class A maximum using a circularly-polarized transmitting antenna. The increased 60 dBu contour would add several small communities to the coverage area, for a 203% population increase.

4. FM Station WMEA, 90.1 MHz, Channel 211C, Portland, Maine - This station is licensed to Maine Public Broadcasting Corporation. It is collocated with TV6 Station WCSH, and operates with a nondirectional transmitting antenna operating at 24.5 kW ERP (circular polarization), close to the maximum afforded by FCC Rules Section 73.525(d)(1). Our allocation study findings show that lacking the FCC Rules Section 73.525 power restriction, WMEA could increase power to the 55 kW ERP, nondirectional. In that case, population within the 60 dBu contour is projected to increase by 18.2%.

5. FM Station WYFS, 89.5 MHz, Channel 208C, Savannah, Georgia - WYFS is licensed at Class C maximum 100 kW ERP using a directional transmitting antenna, but only at 183 meters HAAT, so technically the station would be considered Class C1. The elliptical polarization (but nearly circular at 100 kW ERP horizontal/91 kW ERP vertical) directional transmitting antenna pattern was specifically identified as most likely being used to protect the TV6 Station WJBF viewing area, to the north-northwest. Our allocation study findings show that lacking the FCC Rules Section 73.525 restrictions, a nearly circular azimuth pattern directional antenna could be substituted, operating with 100 kW ERP circular polarization. Population within the 60 dBu contour is projected to increase by 17.2%.

Specific Issues Affecting Study Findings

As discussed above, many noncommercial FM stations that have been limited since the early 1980s to protect NTSC TV6 stations may still not be allowed to increase power or coverage area due to existing allocation conditions with other FM stations. However, our study showed that 4 (16%) and perhaps 5 (20%) of the 25 sampled study stations could increase power and coverage if the TV6 restrictions of FCC Rules Section 73.525 were deleted. Because of the nature of the FCC's rules, though, it is believed that at least some of these upgrades could be accomplished under the present regulatory climate, particularly the provisions that allow virtually unrestricted interference agreements with NTSC TV6 stations. The deletion of Section 73.525 would streamline the ability of NCE-FM stations to improve facilities if they wish, but such an action would not likely present the *only* option for presently affected stations.

Another issue that we have researched as a part of this project has been how to quantify the improvement gained by changing transmitting facilities from vertically-polarization only or elliptical polarization to circular polarization. Contour projections, either by FCC or terrain-sensitive methods, yield essentially the same population for any polarization scenario. Theoretically, circular polarization does add 3 dB of radiated power over vertical polarization, but no receiving antennas are in general use that can make simultaneous use of all energy from both horizontal and vertical polarizations. Anecdotally, we know that circular polarization is better for FM broadcasting because it provides added field strength to receiving antennas of any random polarization, but numerically quantifying the number of persons in a given coverage area receiving the signal under use of a circularly-polarized transmitting antenna, versus use of a vertical polarization-only or elliptical polarization antenna, is quite difficult.

Some field study work was conducted in the 1960s that led the FCC toward authorization of dual and circular polarization FM transmitting antennas. However, the initial polarization used for FM broadcasting was horizontal, and stations later converted to H/V or circular polarization. In the case of present day NCE-FM stations within or near TV6 coverage areas, primarily vertical polarization is employed, and elimination of FCC Rules Section 73.525 would allow addition of the horizontal component. Mobile reception of FM broadcasts, by virtue of present and past automotive designs, is best suited for vertical polarization, so no dramatic improvement would be expected from a vertical-to-circular polarization conversion, as was most certainly the case in the 1960s and 1970s during conversion from horizontal-only to circular polarization.

Conclusion

Based on the existing variable regulatory climate with respect to NCE-FM/TV6 protection, as well as present uncertainties regarding determination of perceived differences between vertical-only and circular polarization, the creation of "improvement factors" was deemed too unreliable for practical application. However, the study did yield the result that approximately 20% of the 407 NCE-FM stations presently required to protect NTSC Channel 6 reception areas in some fashion could, in the event that FCC Rules Section 73.525 were deleted, improve technical

facilities and associated coverage areas. In such a case, the average 60 dBu contour population increase was found to be 75%.

As always, we appreciate the opportunity to be of service. Please let us know if you have questions or additional needs.

Sincerely

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Enclosures